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THE FOSSIL FISHES COLLECTED BY THE CENTRAL ASIATIC EXPEDITIONS[1]

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INTRODUCTION

Among the palæontological materials collected by the Central Asiatic Expeditions of The American Museum of Natural History, there is an interesting small collection of fossil fish remains. Like the other palæontological specimens of these expeditions, the fishes were collected in the Gobi desert, Mongolia, and are from several different formations.

At the suggestion of Dr. Walter Granger, of The American Museum of Natural History, Chief Palæontologist of the Central Asiatic Expeditions, I have made a study of these specimens, and present the results in this paper. My thanks are due to Dr. Granger for transcripts from his field notes of data on the localities and formations from which the specimens were obtained.

The materials covered by this paper include the fossil fishes collected by all the field expeditions, from 1922 to 1930. Only the few specimens of *Lycoptera* figured by Cockerell in 1925 (3) were not available for this study; however, the clear illustrations from photographs, in his paper, made it possible to take those specimens also into account in the study of that species.

Berkey and Morris' volume, "Geology of Mongolia" (1), afforded helpful information on the geology, and showed which formations are of freshwater origin.

SUMMARY OF THE SPECIMENS AND THEIR GEOLOGIC OCCURRENCE

The groups of fossil fishes collected by the Central Asiatic Expeditions, and the special points regarding them discussed in this paper, may be summarized as follows:

1. Specimens of a small, primitive teleostean, genus *Lycoptera*, from the Lower Cretaceous (Ondai Sair formation).

[1]Publications of the Asiatic Expeditions of The American Museum of Natural History. Contribution No. 114.

This little fish is of considerable theoretic interest because of Professor Cockerell's suggestion (3) that this family, the Lycopteridæ, probably represents the ancestral forms of the Cyprinidæ. This view is briefly examined in connection with the description of the species, which I find to be new.

2. Many detached bones and vertebræ from the Eocene formations. These specimens constitute the bulk of the Mongolian fish collection.

The majority of these remains represent a large amioid fish, 5 or 6 feet in length, of the genus *Pappichthys*. This genus was heretofore known by four species, all from the Eocene (Bridger beds) of Wyoming, and represented by mere fragments, jaw elements and vertebræ.

The Mongolian species is distinct from the American; and the material in the collection acquaints us with a number of skeletal elements of *Pappichthys* not found before.

With these amioid remains were collected a few opercular bones referable to the existing teleostean genus *Catostomus* (or a genus very close to it), and a few small vertebræ of catostomids or Cyprinidæ.

3. Pectoral spines of a catfish, a new species of the genus *Rhineastes*, from the Pliocene (Tung Gur beds).

The species represented in the collection, and their geologic horizons, are shown in the following table.

THE GOBI FORMATIONS IN WHICH FISHES WERE FOUND BY THE ASIATIC EXPEDITIONS AND THE SPECIES FROM EACH

Period	Formation	Fishes
Pliocene	Tung Gur	*Rhineastes grangeri*, n. sp.
Eocene	Shara Murun[1]	*Pappichthys mongoliensis*, n. sp. *Catostomus* sp. Cyprinid vertebræ
	Tukhum	(No fishes found)
	= Ulan Shireh	*Pappichthys mongoliensis*
	= Irdin Manha	*Pappichthys ? mongoliensis* n. sp.
Cretaceous	Ondai Sair (Paper-shale)	*Lycoptera fragilis*, n. sp.

[1]In an oral communication, Dr. Walter Granger states that the Shara Murun rests directly upon the Tukhum and therefore is of somewhat later age. The Tukhum, Ulan Shireh and Irdin Manha are equivalent horizons at three different localities.

DESCRIPTION OF SPECIES

LYCOPTERIDÆ

There are several specimens in the collection, of an interesting little fish of the genus *Lycoptera*, from the Ondai Sair paper-shale formation. These paper-shales contain fossil insect larvæ, and other invertebrates belonging to freshwater groups, and hence it is evident the *Lycoptera* found with them was a freshwater fish. The age of the formation, as determined by Cockerell (2) from a study of the biota, appears to be Lower Cretaceous.

The specimens I had for study were all incomplete fishes. But by matching three specimens, each supplying parts missing in the others, I was able to make out the entire form of the fish, and to draw an outline restoration of it (Fig. 6).

The genus *Lycoptera* was established as long ago as 1847, by Johannes Müller, for specimens from eastern Siberia. It was formerly included among the Leptolepidæ (Woodward, 12), but was separated by Cockerell as a distinct family (2).

Cockerell, in a paper on the affinities of *Lycoptera* (3), regarded the Mongolian fish as identical with Müller's Siberian species—*L. middendorffi*. However, the following facts indicate that the Mongolian fish is a distinct species.

In the original description of the species, Johannes Müller states that the dorsal begins a little *behind* the origin of the anal; and his lithograph figure of the type specimen confirms this statement (9, Pl. XI, fig. 1). This, then, defines the position of the dorsal and anal relative to each other in *middendorffi*.

Others who examined specimens from the Siberian formation also state that the dorsal begins a little behind the origin of the anal—Eichwald (5), Woodward (12), Reis (11).[1]

In the Mongolian species, on the other hand, about three-fifths of the dorsal is in *advance* of the anal. And there are other differences from the Siberian fish, as in the shape of the head and the number of fin-rays in the unpaired fins. By present ichthyologic standards, these differences mark the Mongolian fish as a distinct species; and I therefore describe it here as new.

[1]Reis says: "Die Dorsalis steht gegenüber, mit ihren Vorderrand aber etwas hinter dem der Analis." This agrees with Johannes Müller's description. But in his enlarged restoration the position of these fins is not so represented. If his figure is correctly drawn, then a second species was present in his material in addition to *L. middendorffi*.

Lycoptera fragilis, new species

Figures 1–6

COTYPES.—Three incomplete fishes, on small pieces of brown paper-shale: (1) Impression of the front half of a little fish as far as the ventrals (Fig. 1). (2) A fish lacking the head and caudal but showing the pectoral, ventral, dorsal and anal (Fig. 3). (3) Caudal fin (Fig. 2). All are in the American Museum of Natural History.

FORMATION AND LOCALITY.—Ondai Sair paper-shales (Lower Cretaceous); Uskuk, Mongolia. R. W. Chaney, 1923.

A fish about 10 cm. in total length (including caudal). Head longer than the depth, about 3⅔ in length to base of caudal. Head, in lateral view, pointed; mouth small; lower jaw projecting slightly beyond upper. Maxilla apparently reaching beyond eye.

Dorsal 11, anal 13. Dorsal in advance of anal by about three-fifths of its base; its origin a little behind vertical through end of ventral fin when adpressed to body. One or two short, delicate fulcra in front of first dorsal ray; the third or fourth ray of dorsal the highest. Anal a trifle larger than dorsal.

Pectorals relatively large, attached immediately behind cleithrum, and extending two-thirds of distance from their origin to the commencement of the ventrals. Ventrals small, placed about midway between end of pectorals and origin of anal.

Caudal deeply forked, with a few slender, imbricated fulcra at origin of upper lobe.

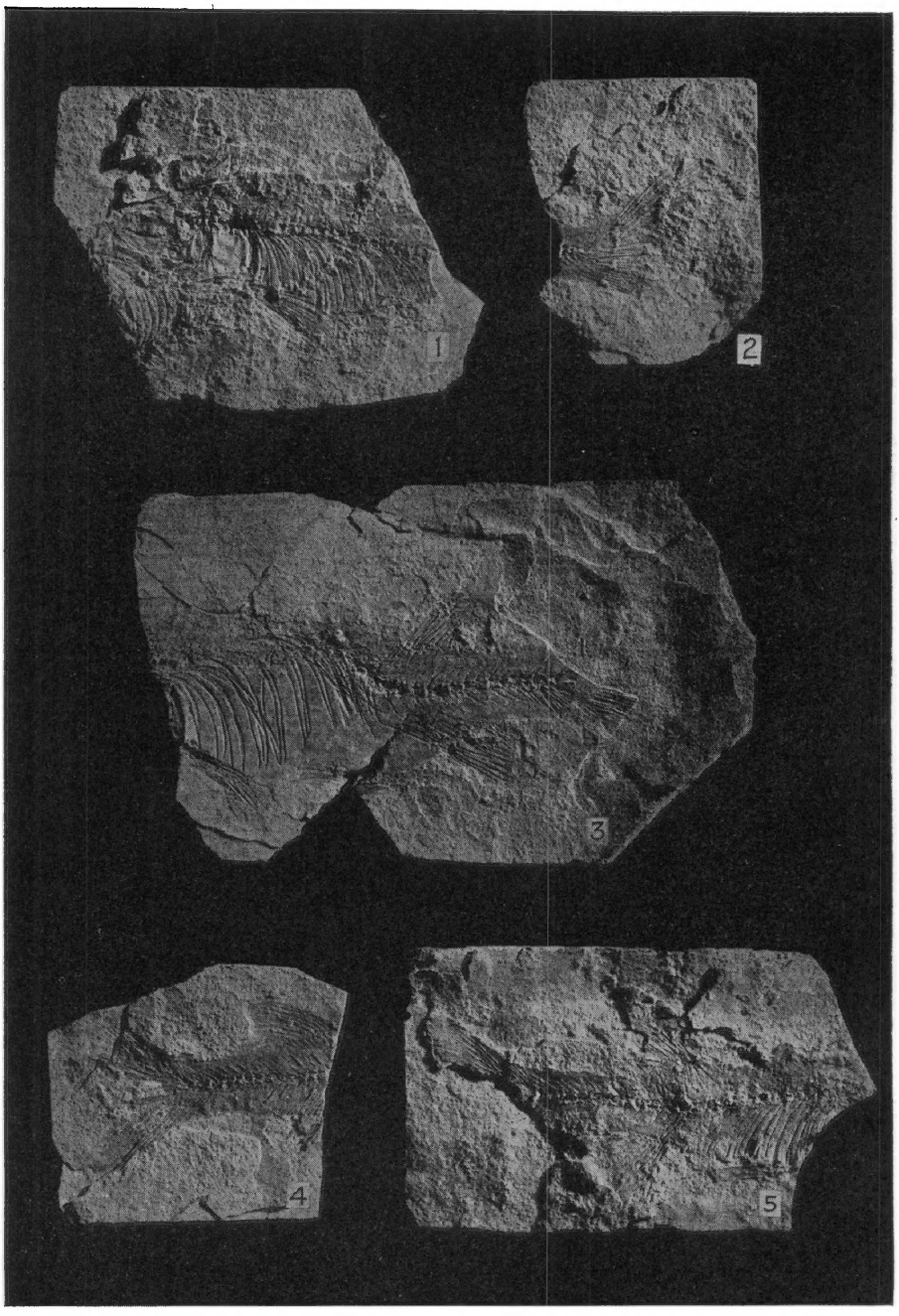
Cotypes (1) and (2) show impressions of delicate, arched ribs, which are more slender than those shown in Woodward's restoration of *L. sinensis* (12, fig. 1).

Three other species of the genus *Lycoptera* are known: *L. middendorffi* Müller, from eastern Siberia (Upper Jurassic); *L. sinensis* Woodward, and *L. ferox* Grabau, from the Province of Shantung, China (Cretaceous). These little fishes resemble one another in size and general form, and it requires close examination to determine which species one has in hand.

The points in which *L. fragilis* differs from *L. middendorffi* have already been noted. From *L. sinensis* and *L. ferox*, it is distinguished especially by the shape of the head: in *fragilis* the head is pointed, with the lower jaw projecting a little beyond the upper, whereas in these two species the snout is rounded, elevated, and projects beyond the lower jaw. There are also other differences, as in the number of fin-rays, the relative size of the pectoral, etc.

THE AFFINITIES OF THE LYCOPTERIDÆ

Cockerell, in a paper discussing the affinities of *Lycoptera* (3), made the interesting suggestion that these little fishes are probably the ancestral forms of the Cyprinidæ. His main reason for this view is the close resemblance in the surface sculpturing of the small, cycloid scales of *Lycoptera* to those of some existing genera of Cyprinidæ, especially the European minnow, *Phoxinus phoxinus*. In addition, the Lycopteridæ are freshwater fishes like the vast majority of existing cyprinids.



Figs. 1–5. *Lycoptera fragilis*, n. sp. Figs. 1, 2, 3, the cotypes. Natural size.

The question of how far the fine markings on fish scales may be considered a criterion of relationship has never been critically examined. Professor Cockerell, in numerous papers on fish scales, has described and illustrated the minute scale markings in many families and a great many genera. These studies have demonstrated that in certain families of fishes a marked similarity in scale sculpturing runs through the different genera, so that in such cases isolated scales may be confidently assigned to their respective families by the scale markings alone.

But Professor Cockerell's studies have also brought to light instances where families which are phylogenetically widely separated show a remarkable similarity in scale markings. For example, in his paper on *Lycoptera* (3), he describes the scales of *Leptolepis dubius* of the Upper Jurassic, and says:

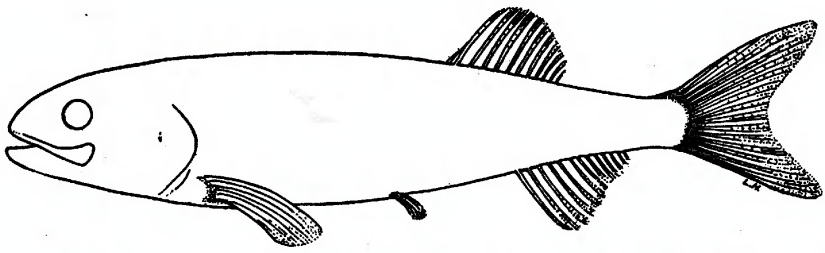


Fig. 6. *Lycoptera fragilis*, n. sp. Outline restoration, natural size.

"Now it is singular that the features of this scale, even to the interference of the circuli laterally and the indication of ridges from the nucleus to the laterobasal corners, are very nearly those of the living *Caranx hippos*." (3, p. 315).

Here, then, we have two forms, the one a primitive isospondyl, the other a carangid, quite remote from each other in relationship, and yet, if we took scale-sculpturing as the criterion of affinity, we should have to consider them related families. This case shows clearly that resemblance in superficial scale detail is not a reliable criterion of phylogenetic relationship. In some cases the resemblance seems to be the result of parallelism.

We cannot therefore accept the resemblance in scale markings of *Lycoptera* and some Cyprinidæ as decisive evidence of affinity between the two groups.

But there are several other points in which *Lycoptera* approaches the Cyprinidæ: (1) The presence of cycloid scales. (2) The arrangement and structure of the fins. (3) Freshwater habitat.

Furthermore, Regan (10) concluded from a systematic review of the cyprinid fishes of the world, that the group probably originated in Asia. Hence we expect to find the fossil ancestors of the Cyprinidæ somewhere in those geological horizons at which the Lycopteridæ actually occur.

These facts lend support to Professor Cockerell's view that the Lycopteridæ are probably the ancestors of the Cyprinidæ. However, it must be borne in mind that the structures of the skull and of the pectoral girdle of *Lycoptera* are still unknown, and have not been compared with those of the Cyprinidæ.

Reis figured the opercular elements of *Lycoptera*, but their form is not distinctive enough to throw any light on the question of affinity. He also figured a gular plate in *Lycoptera*. Although such an element has not been demonstrated in any existing genus of the Cyprinidæ, yet its presence in *Lycoptera* would not militate against the suggested relationship, for we rather expect to find a gular plate in an ancient fish closely allied to the Leptolepidæ.

To sum up: Several facts point to the Lycopteridæ as probably the group from which the Cyprinidæ arose. But definite solution of the question must wait until the structure of the skull and pectoral girdle of *Lycoptera* becomes available for comparison with those of the more generalized existing cyprinids.

AMIIDÆ

Genus **Pappichthys** Cope

The majority of the fossil fishes collected by the Central Asiatic Expeditions are isolated bones and vertebræ from the Gobi Eocene formations. They represent an amioid fish, genus *Pappichthys*, much larger than the surviving amioid the bowfin (*Amiatus calvus*),[1] being five or six feet in length.

The genus *Pappichthys* was established by Cope on jaw elements and vertebræ from the Eocene (Bridger beds) of Wyoming. He described four species (4). A few fragments have also been found in the Upper Cretaceous of Montana and of Saskatchewan, and in the Paleocene of Alberta, as noted in Hay's Bibliography (7).

Since *Pappichthys* is known at present only from detached bones, its exact distinction from *Amiatus* cannot be indicated. But I have

[1]The name *Amia*, by which the existing amioid is commonly known, was first applied to a genus of living teleosts, for which it is in use at the present time. Hence this name cannot be retained for the amioid. Rafinesque wrote the name of the amioid, *Amiatus* (Jordan, 8), and some ichthyologists have begun using this name as the earliest synonym. In the present paper, I likewise use *Amiatus*.

found points of difference in nearly every bone available for comparison, and it appears that *Pappichthys* is a valid genus, not merely a group of large-sized, extinct species of *Amiatus*.

Cope stated that *Pappichthys* differs from *Amiatus* in having "only one series of teeth instead of several, on the bones of the mouth." (4) But this opinion was based on an error in comparison. It is evident that he had compared a mandible of *Pappichthys*, from which, as is generally the case, the delicate splenial bone with its small teeth had been lost, leaving only the row of large teeth on the dentary, with a complete *Amiatus* mandible retaining the splenial teeth. Hence the seeming difference in dentition.

In the Mongolian mandibles of *Pappichthys* at hand, the splenial is also lacking; and I find it is also frequently lost in skeletal material of *Amiatus*.

A direct comparison of a *Pappichthys* mandible with one of *Amiatus* without the splenial, shows a complete agreement in tooth arrangement. In both genera there is a single row of large, slender-conical teeth on the dentary, occupying the front two-thirds of the upper margin of the mandible.

The Mongolian material of *Pappichthys* consists of several groups of bones and vertebræ collected at different localities. Each group includes remains of more than one fish. I have selected from one of the groups several representative elements to serve as the cotypes of the Mongolian species, limiting the cotypes to elements which almost certainly belong to the same species.

Pappichthys mongoliensis, n. sp.

Figures 7–24

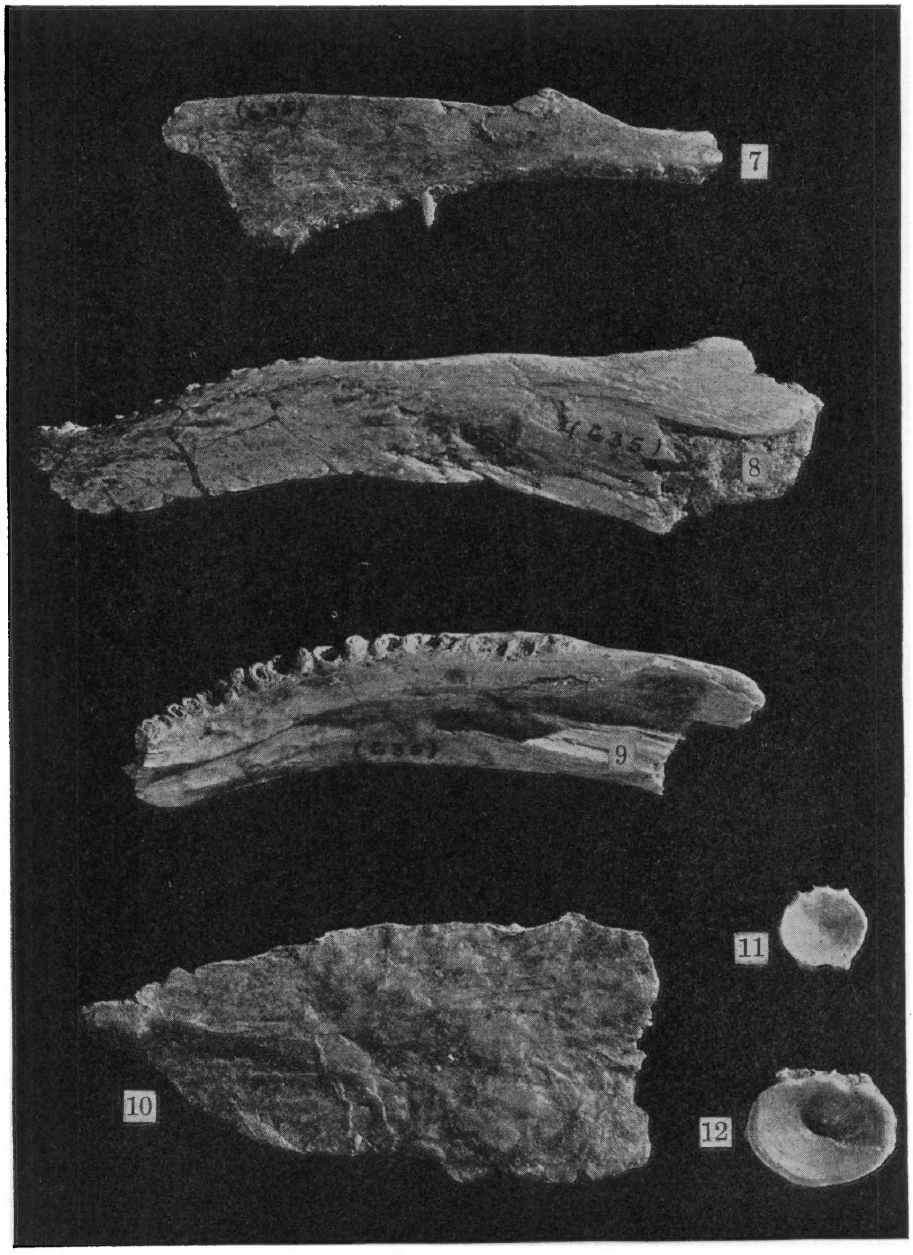
COTYPES.—The specimens shown in Figs 7–12—namely, a right and a left mandible of about the same size; a right maxilla; a gular plate; two vertebræ. They were all collected together but obviously belong to more than one fish. In the American Museum of Natural History.

FORMATION AND LOCALITY.—Eocene (Ulan Shireh beds); North Mesa, Shara Murun region, Inner Mongolia. Field No. 635; "Chimney Butte" Quarry, 1928.

The principal land animals in this formation are titanotheres and chalicotheres.

An amioid fish about 5 feet in length, known by detached bones and vertebræ. The mandible (Figs. 8, 9; 13B) is twice as large as that of the existing *Amiatus calvus*, and relatively much less deep in its posterior half, in outer view. The dentigerous area occupies two-thirds of the upper margin of the dentary, and there are alveoli of 19 teeth. Back of the teeth, the upper margin of the dentary is rounded and smooth.

The maxilla (Fig. 7) is of the same form as in *Amiatus*, but twice as large. The teeth are slender-conical, similar in form to those of the living genus, but much larger; some have the points flexed inward.



Figs. 7–12. *Pappichthys mongoliensis*, n. sp. Cotypes. About natural size.

7. Right maxilla, outer view. 8. Left mandible, incomplete at posterior end; outer view. 9. Right mandible, incomplete; inner view. 10. Gular plate, outer view. 11. Caudal vertebra from a small fish. 12. Abdominal vertebra.

The gular plate is shown in Fig. 10. This is the first time this element of *Pappichthys* has been found. The specimen is of about a size to go with the cotype mandibles. The bone is very thin, and at the anterior extremity, in the median line, there is a low, rounded ridge, as in *Amiatus*, strengthening the bone at the point of attachment to the mandibular symphysis. The ridge narrows backward, and disappears beyond the first fourth of the length of the plate.

Vertebræ of the typical amioid form; that is, very short in antero-posterior diameter, and the vertebræ of the abdominal region much wider than high.

Measurements of the abdominal vertebra shown in Fig. 12: Width, 19 mm.; height, 14.5; thickness (i.e., antero-posterior length), 6.5. Vertebra in Fig. 11: Width, 11.5 mm.; height, 10; thickness, 4.5.

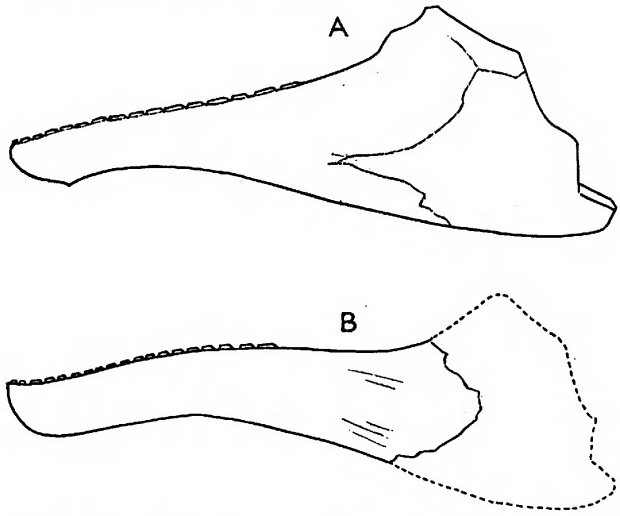


Fig. 13. Mandibles of (A) *Amiatus calvus*, and (B) *Pappichthys mongoliensis*, reduced to same size to show difference in shape.

Judging by the size of the mandibles, *Pappichthys mongoliensis* was a fish about as large as *P. corsoni* and *P. plicatus* of the Bridger beds (Eocene) of Wyoming, but smaller than *P. sclerops* and *P. lævis* of that formation. The latter two, as shown by the mandibles and vertebræ figured by Cope (4), must have been fishes about 7 feet in length, whereas the Mongolian species was about 5 feet.

In *P. sclerops* and *P. lævis*, the mandible is relatively deeper, and somewhat different in form from that of *P. mongoliensis*.

The two vertebræ included among the cotypes of *P. mongoliensis* (Figs. 11, 12), are very similar to the *Pappichthys* vertebræ figured by Cope from the Eocene of Wyoming (4). The abdominal vertebra shown in Fig. 12 is exactly of the size and form of those of *P. corsoni* shown in Cope's figures of that species.

NOTES ON ADDITIONAL SPECIMENS OF *PAPPICHTHYS*

In addition to the type material of *Pappichthys mongoliensis*, there are in the collection a number of isolated bones which had not been found previously in the genus, and a few other elements, like the mandibles, which, although already known, add somewhat to our knowledge of these structures. In the following notes these specimens are briefly described. They are illustrated in Figs. 14 to 22.

MANDIBLES AND DENTITION.—The fragment of a mandible shown in Fig. 22 is the first specimen of this bone found to show the teeth, all previous specimens having shown only the alveoli. Five teeth are preserved in this fragment. They are slender-conical, like those of the existing *Amiatus*, but larger.

This specimen is from the same formation and locality as the cotypes of *P. mongoliensis* and appears to belong to that species.

There is also in the collection a series of mandibles of *P. mongoliensis* of different sizes, all collected together. They grade from small, half-grown mandibles to large ones like the two included among the cotypes; they show that no material change took place in the shape of the mandible after the fish was half grown.

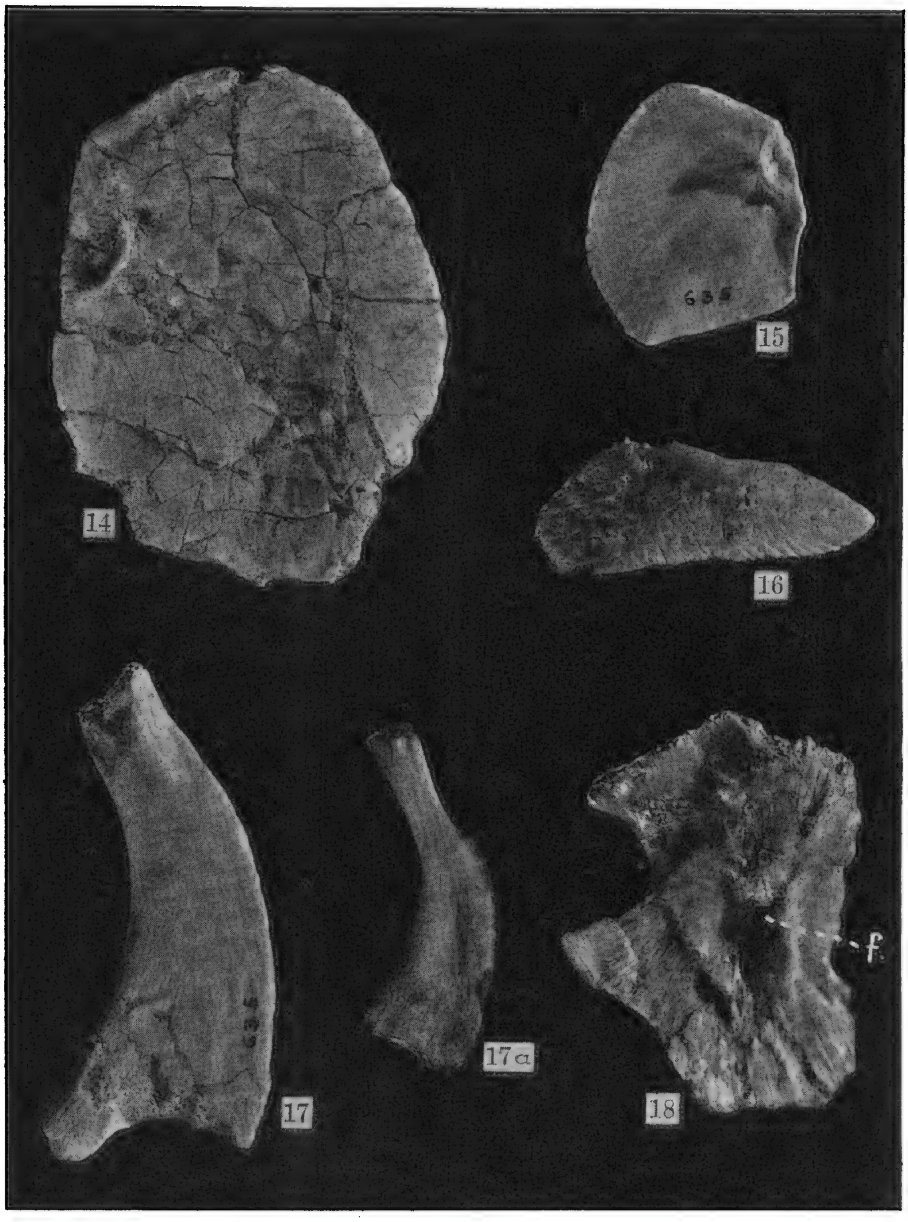
VOMERINE DENTITION.—With the mandibles just noted was found a fragment of the vomerine dentition. It consists of a patch of small, conical teeth set close together on a fragment of thin bone about half an inch in diameter. In both form and arrangement these teeth resemble the vomerine dentition of *Amiatus*.

SKULL ELEMENTS.—The skull of *Pappichthys* was heretofore known only by a few fragments (Cope, 4, Pl. III). In the present collection there are several complete, detached skull bones, collected with the cotypes of *P. mongoliensis*. These elements are all similar in form to their homologues in *Amiatus*, differing only in details. It thus appears probable that the head of *Pappichthys* was similar in shape to that of *Amiatus*.

SUPRATEMPORAL.—In Fig. 16 is shown one of the pair of supratemporals. In the Amiidæ these bones are elongated triangles placed transversely to form the posterior margin of the skull roof. The bone is of the same shape as in *Amiatus*, but somewhat more pointed. The ornamentation of the outer face is well shown in the figure.

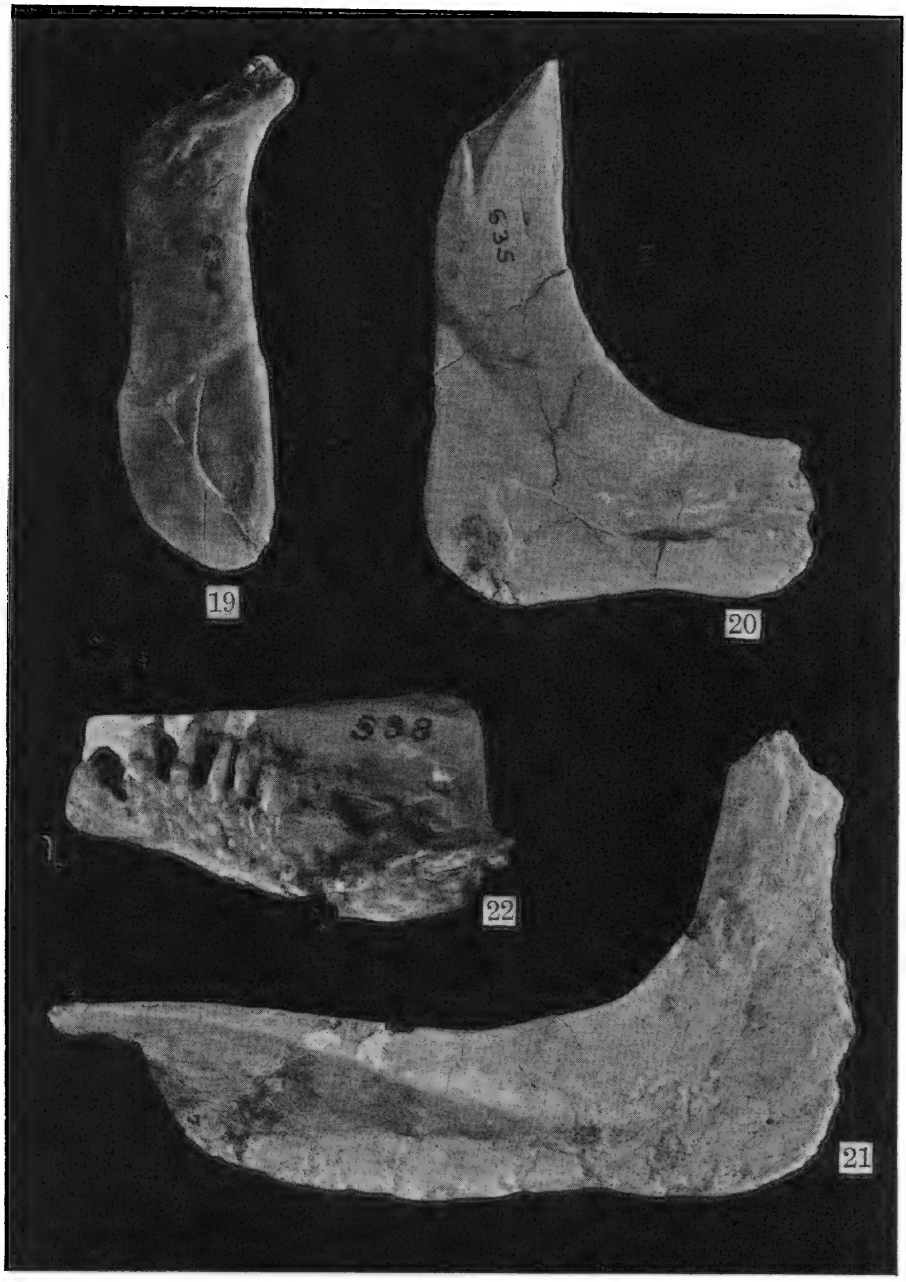
OPERCULUM.—From an examination of *Amiatus* crania of different sizes, it appears that in the adult fish the operculum and subopercular become ankylosed, the suture between them growing more or less obliterated. The same condition occurs in *Pappichthys*. The specimen in Fig. 15 is an operculum of a small fish, complete in itself, while that shown in Fig. 14 is the combined operculum and subopercular of a large fish, with the suture between them only partly traceable.

The *Pappichthys* operculum is a little narrower proportionally to height than that of the bowfin; and the notch for the reception of the anterior extremity of the subopercular is shallower (cf. Figs. 23A, B). The form of this notch appears to be constant for each species; I found it always of the same form in a number of *Amiatus* opercula examined. In *Pappichthys* the operculum is only scantily ornamented on the outer face, its upper third and the margin all around being almost smooth.



Figs. 14–18. *Pappichthys mongoliensis*, n. sp. About natural size.

14. Combined operculum and subopercular of a full-grown fish: inner view. 15. Operculum of a young fish, inner view. 16. Supratemporal, outer view. 17. Ceratohyal. 17*a*. Ceratohyal of *Amiatus calvus* for comparison. 18. Hyomandibular; *f*, foramen.



Figs. 19–22. *Pappichthys mongoliensis*, n. sp. Natural size, except Fig. 22.

19. Supracleithrum, outer view. 20. Vertical limb of a cleithrum. 21. Cleithrum showing the complete lower limb. 22. Fragment of a mandible showing teeth. ×1½.

HYOMANDIBULAR.—There is one example of this bone in the collection, the first to be found in the genus (Fig. 18). It is similar in general form to that of *Amiatus*, but the semicircular excision on the anterior margin is relatively deeper. The bone is twice as large as in *Amiatus*.

CERATOHYAL.—An incomplete right ceratohyal, collected with the cotypes, is shown in Fig. 17. As far as preserved, it is exactly of the form of this bone in *Amiatus*, cf. Figs. 17, 17a.

PECTORAL GIRDLE.—This is the first time that portions of the pectoral girdle of the genus *Pappichthys* have been found. Two of its elements are represented in the collection—the cleithrum, of which there are several specimens of different sizes, and a supracleithrum. From these bones it is evident that the pectoral arch of *Pappichthys* was similar in form to that of *Amiatus*, differing only in details.

Two specimens of the cleithrum are illustrated in Figs. 20, 21, one showing the entire vertical limb, the other the entire horizontal limb. The bone differs from that of *Amiatus* chiefly in the shape of the vertical limb, which is relatively broader and does not taper so much as in the existing genus.

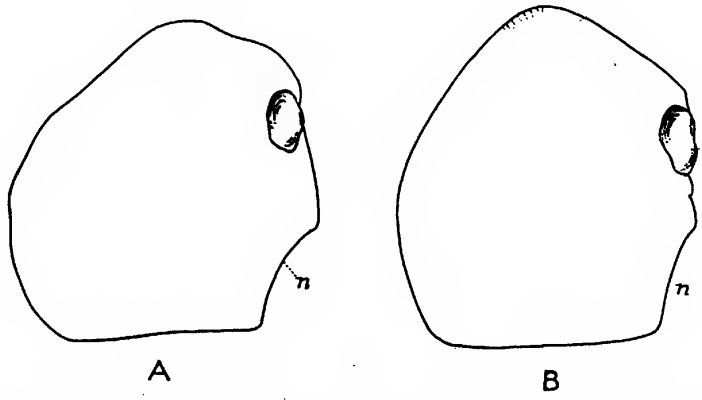


Fig. 23. Opercula of (A) *Amiatus calvus* and (B) *Pappichthys mongoliensis*, reduced to same size to show difference in outline and in the notch, *n*.

The supracleithrum is usually termed supraclavicle. But since the bone of the pectoral arch, once called clavicle, is now generally named cleithrum, it would appear more correct to term the bone overlying it, supracleithrum, not supraclavicle; I accordingly use this name for this element of the pectoral girdle.

The bone (Fig. 19) is similar in form to that of *Amiatus*, but twice as large. Its outer face is smooth save for a few faint vertical wrinkles near the lower margin.

MEASUREMENTS.—Height, 65 mm.; width (at middle of lower expanded portion), 20 mm. The corresponding measurements in a full-grown *Amiatus* are 33 mm. and 9.5 mm. respectively.

VERTEBRÆ.—Many vertebræ of different sizes, some as small as those of *Amiatus*, were collected from the Ulan Shireh beds in the Shara Murun region, the type locality of *Pappichthys mongoliensis*. They appear all to belong to this species. Six of them, selected as representative of the different forms and sizes, are shown in Fig. 24.

GEOLOGIC RANGE OF *PAPPICHTHYS* IN MONGOLIA

In addition to the foregoing specimens of *Pappichthys*, which are all from the Ulan Shireh beds, vertebræ of this genus were collected from two other Eocene formations. They are indistinguishable from those found in the Ulan Shireh, and I provisionally assign them to *P. mongoliensis*. The formations and localities from which they were collected are as follows:

(1) A dozen vertebræ of various sizes. Irdin Manha formation (Eocene); 23 miles south of Iren Dabasu, Inner Mongolia. Expedition of 1923. Field No. 156.

(2) One large vertebra. Shara Murun formation (Eocene); Ula Usu, Inner Mongolia. Expedition of 1925.

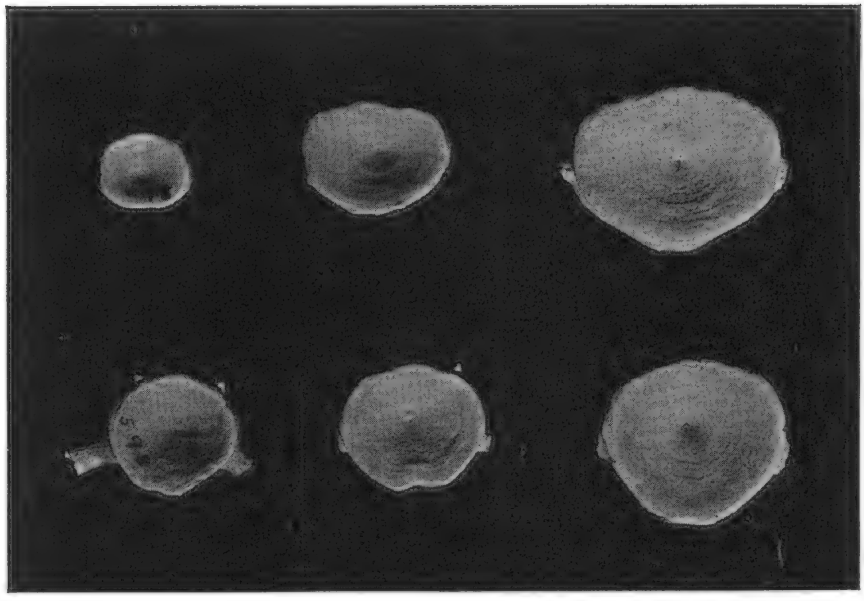


Fig. 24. *Pappichthys mongoliensis*. Six vertebræ of different sizes, selected from a group found together. Natural size.

The sequence of the formations in which *Pappichthys* was found, and their thicknesses, as determined by the geologists of the Central Asiatic Expeditions, are shown in the following table. The letter *P* indicates the formations in which *Pappichthys* was found.

Eocene	Shara Murun	200 ft.+	*P*
	Tukhum =Ulan Shireh =Irdin Manha	150 ft.+	 *P* *P*

Pappichthys thus ranges through a thickness of more than 350 feet of strata, indicating that it existed in the Gobi region for an immense length of time. It is probable that during this vast time some specific differentiation occurred, and that more than the one species of *Pappichthys* described in this paper are represented among the isolated, partly worn vertebræ of different sizes collected by the expeditions. In the Eocene of western North America four species of *Pappichthys* have been found.

CATOSTOMIDÆ

Catostomus sp.

Figure 25A

Several detached bones of teleostean fish of the genus *Catostomus* were found with the *Pappichthys* remains, in the Ulan Shireh formation. The specimens include three opercula and two subopercula from fishes about 15 inches in length, and a few small vertebræ.

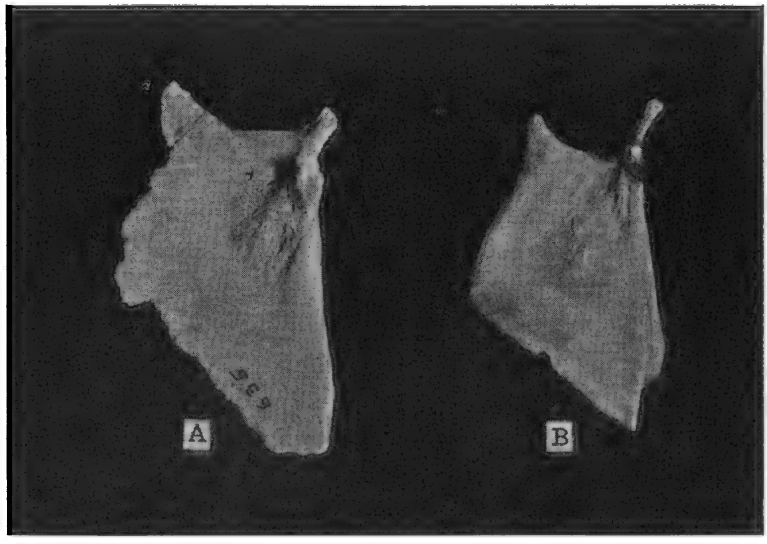


Fig. 25. A, Operculum of *Catostomus* from the Ulan Shireh formation; lower margin incomplete. B, same of *Catostomus commersonii*, a living species. Both in inner view; natural size.

The operculum in the genus *Catostomus* (Fig. 25B) is distinguishable from that of related genera by the presence of a short, slender process at the upper anterior angle of the bone. This process is present in the Gobi operculum (Fig. 25A), making the generic identification practically positive.

The Gobi suboperculum is also similar in form to that of the Catostomidæ; it is almost exactly like that of *Catostomus commersonii*, a species now living in the rivers of temperate North America. In this living species the anterior margin of the suboperculum is drawn out upward into a sharp slender process. A similar slender process is present in the Gobi suboperculum.[1]

The Gobi species is probably new, but it seems to me that these two opercular bones alone do not afford sufficiently distinctive characters for describing it.

Along with these *Catostomus* bones was collected an operculum of a second genus probably of this family.

Judging by the character of the matrix, there appears to be no doubt that these catostomid bones are derived from the Ulan Shireh beds and not from a later formation. Hence we have here a *Catostomus* of undoubted Eocene age. This makes this family one of the most ancient of living teleosts.

The Catostomidæ were previously known by fossils from as early as the Miocene, being represented by the genus *Amyzon* in the Florissant shales of Colorado and an equivalent formation in British Columbia.

SILURIDÆ

The expedition of 1930 obtained two pectoral spines of a new species of catfish of the genus *Rhineastes*. This genus is known only by fossil fin-spines.

Rhineastes grangeri, new species

Figure 26

TYPE.—Proximal half of a right pectoral fin-spine (Fig. 26). Length as far as preserved, 4 cm. The specimen is in the American Museum of Natural History.

FORMATION AND LOCALITY.—Tung Gur beds (Pliocene); 50 miles southeast of Iren Dabasu, Inner Mongolia.

Pectoral spine about 7 cm. in length—indicating a catfish of 1½ to 2 feet. Sides of spine ornamented with incised lines, which in places produce the effect of low flutings; these are here and there broken up into elongated dots and short, irregular lines. Posterior margin of spine bears large denticles of the form shown in Fig. 26*d*. They are not compressed, and the outer surface of each denticle (i. e., the surface facing the point of the spine) has a shallow channel extending to the point of the denticle. The anterior margin of the spine bears a row of very small, rounded nodes (rather worn and inconspicuous in the type), separated by slight distances, thus giving the cutwater edge of the spine a compressed, delicately serrated edge.

[1]The Gobi specimen showing this process was accidentally damaged while being repaired for me in the palæontological laboratory.

Cross-section of spine, at its middle, approximately elliptical, the long axis of the ellipse about 1½ times the shorter one.

Named for Dr. Walter Granger, Curator of Fossil Mammals in The American Museum of Natural History, and chief of the palæontological division of the Central Asiatic Expeditions.

A second spine of this form was obtained by the 1930 expedition from the same formation as the type, at a locality 40 miles southeast of Iren Dabasu. (Field No. 833.)

This specimen is a little more compressed than the type; the incised lines on the sides are more regular, and the posterior denticles do not show the channeling on the front face clearly (perhaps due to weathering). The fine nodes along the anterior margin, on the other hand, are more distinct than in the type.

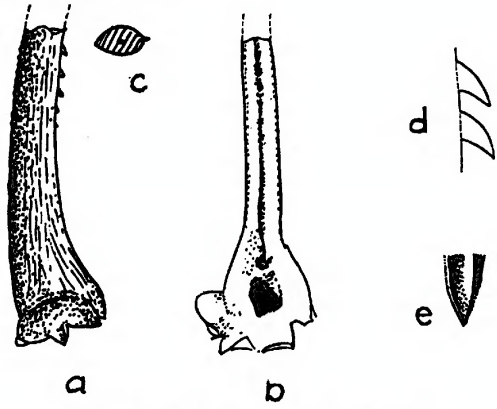


Fig. 26. *Rhineastes grangeri*, n. sp.

a, Type, from the side, natural size; *b*, type, in posterior view; *c*, cross-section of type; *d*, two of the posterior denticles, enlarged. *e*, upper view of a denticle enlarged to show channeling.

This specimen seems to me to be of the same species, *Rhineastes grangeri*, but from a younger fish.

Rhineastes grangeri has a general resemblance in size and form to the catfish spine named by Cope *Rhineastes smithi*, from the Middle Eocene (Bridger beds) of Wyoming (4, Pl. v, figs. 10, 10*a*), but it differs in details, indicating specific distinction between the two fishes.

I have compared *Rhineastes grangeri* with pectoral spines of various catfishes now living in China (e.g., *Clarias*, *Pseudobagrus*, etc.). It resembles them in general form, but in all the Chinese genera I examined the pectoral spines are much more compressed, and the posterior serratures are proportionally very much larger or considerably smaller. Of all the catfish genera with which I compared the *Rhineastes* spines, I find the closest agreement to be with some species of *Arius* of South America.

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